VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR

Docket No. A-6621

Serial No.	Filing Date	Patent No.	Issue Date

Applicant/ Patentee: **Jurgen Schulz-Harder**

Invention: **COOLER, IN PARTICULAR FOR ELECTRIC COMPONENTS**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- ☒ the specification to be filed herewith.
- ☐ the application identified above.
- ☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ No such person, concern or organization exists.
- ☐ Each such person, concern or organization is listed below.

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

FULL NAME ______________________
ADDRESS ______________________
☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

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ADDRESS ______________________
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I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Jurgen Schulz-Harder
SIGNATURE OF INVENTOR ______ DATE: 16.04.99

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

Jürgen Schulz-Harder

Serial No : **Not yet awarded**

Filed :

For : **A COOLER FOR ELECTRICAL COMPONENTS**

Group Art Unit:

Examiner:

PRELIMINARY AMENDMENT

COPY

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Please amend the above-identified application as follows:

In the Specification:

Please delete the current Specification and insert the enclosed "Substitute Specification".

In the Claims:

Please delete claims 1-30 and insert the following new claims:

--31. A cooler, in the form of a heat pipe, having a housing in which an interior space closed to the outside is formed to hold a liquid, vaporizable coolant or heat-transport medium, with at least one first cooling or vaporization area formed in the housing interior for accommodating a heat output and a second condensation area which is formed in the housing and is spatially distant for dissipating heat, the housing comprising: a plurality of plates which are superficially joined to one another and which are provided with a plurality of openings for forming channels which are interconnected and which join the first area and the second area; and at least two metal

layers which follow one another in a stack and are structured to form at least one capillary area which extends between the first cooling or vaporization area and the second condensation area , and that at least one other metal layer is structured to form a vapor channel structure with are least one vapor channel, such that the at least one vapor channel extends between the first area and second area and has a flow cross section which is larger than a flow cross section of the at least one capillary area.

32. The cooler as claimed in claim 31, wherein there is at least one capillary area on either side of the vapor channel structure.

33. The cooler as claimed in claim 31, further comprising flat top and bottom surface.

34. The cooler as claimed in claim 31, wherein the cooler is formed as a rectangular plate, and the first area and the second area are separated on either side of the cooler by an imaginary center plane (M) which runs perpendicular to a lengthwise extension (L) of the cooler.

35. The cooler as claimed in claim 31, wherein the first area has on at least one surface side of the cooler, at least one electrical component or at least one surface for attaching the at least one electrical component.

36. The cooler as claimed in claim 31, further comprising an auxiliary cooling means on at least the second area.

37. The cooler as claimed in claim 36, wherein the auxiliary cooling means is a cooling element which dissipates heat to ambient air or an ambient medium.

38. The cooler as claimed in claim 36, wherein the auxiliary cooling means is one through which an external coolant flows.

39. The cooler as claimed in claim 31, wherein the plurality of plates are structured such that in an area of these plates a widely branched channel system results, the channel system having continuous, post-like areas between a closed top and bottom.

40. The cooler as claimed in claim 31, wherein the plurality of plates are metal layers which form the capillary structure and metal layers which form the vapor channel structure, are each provided with a plurality of openings and wherein the ratio of a closed area to an open area formed by the openings for the metal layers which form the vapor structure is greater than for the metal layers which form the capillary structure.

41. The cooler as claimed in claim 40, wherein the metal layers which form the capillary structure and the metal layers which form the vapor channel structure are structured similarly, the plurality of openings in the metal layers which form the vapor channel structure having a larger cross section than corresponding plurality of openings in the metal layers which form the capillary structure.

42. The cooler as claimed in claim 40, wherein the metal layers which form the vapor channel structure have more openings than the metal layers which form the capillary structure.

43. The cooler as claimed in claim 31, wherein the plurality of openings in one of the at least two metal layers and the plurality of openings in an adjacent metal layer in the

capillary structure in the vapor channel structure in planes of these layers perpendicular hereto form continually changing flow paths between the first and the second area.

44. The cooler as claimed in claim 31, wherein the plurality of openings of at least one metal layer is surrounded by material crosspieces which are joined to one another or which branch in the manner of a network and which form a ring structure around each opening.

45. The cooler as claimed in claim 44, wherein the material crosspieces form a hexagonal ring structure around each opening.

46. The cooler as claimed in claim 44, wherein the ring structure has at least three corner points which form a triangle.

47. The cooler as claimed in claim 31, wherein the first and second areas form continuous post-like or column-like areas.

48. The Cooler as claimed in claim 46, wherein the continuous post-like or column-like areas are formed by the corner points of the ring structure.

49. The cooler as claimed in claim 31, wherein the at least two metal layers are made identical in at least one capillary structure, but adjacent layers are turned one to another.

50. The cooler as claimed in claim 1, wherein a structured area of the at least one metal layer has angular openings or breaches.

51. The cooler as claimed in claim 31, wherein the other metal layers for at least one vapor channels structure has additional openings or breaches.

52. The cooler as claimed in claim 31, wherein the at least one metal layer which forms the capillary structure in a structured area is provided with a plurality of slotted openings.

53. The cooler as claimed in claim 52, wherein to form the capillary structure, metal layers of a first type in which the slots extend in a first axial direction, and metal layers of a second type are used in which the slots extend in a second axial direction which includes an angle with the first axial direction.

54. The cooler as claimed in claim 53, wherein the angle is 90°.

55. The cooler as claimed in claim 31, wherein the at least the metal layers for the capillary structure on at least one surface side are provided with a plurality of groove-like depressions.

56. The cooler as claimed in claim 31, wherein the at least one capillary structure is formed by at least one channel in which there is a material which supports and/or produces a capillary action.

57. The cooler as claimed in claim 56, wherein the material which supports and/or produces a capillary action is a powder selected from metal oxide, aluminum, copper oxide, aluminum oxide, ceramic or combinations thereof.

58. The cooler as claimed in claim 31, wherein the at least two metal layers are partially made from metal.

59. The cooler as claimed in claim 31, wherein the thickness of the at least two metal layers is approximately 100 - 1000 microns.

60. The cooler as claimed in claim 31, wherein structure widths are in the range between 50 - 1000 microns.

61. The cooler as claimed in claim 31, wherein the at least one capillary structure is formed by at least two metal layers and the at least one vapor channel structure is formed by at least one metal layer.--

REMARKS

Applicant has provided a Substitute Specification, marked-up copy of the original specification, and replacement claims. No new matter has been added to the application.

Respectfully submitted,

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April 14, 1999
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Attorney Docket No: **A-6621.PAM/cat**

"Substitute Specification"

A COOLER FOR ELECTRICAL COMPONENTS

BACKGROUND OF THE INVENTION

The invention relates to a cooler, in particular, a cooler for electrical components, in the form of a heat pipe.

Coolers of this type are fundamentally known and are based on the principle of vaporization and condensation of a coolant, or heat transport medium, housed in the closed interior of the cooler. Generally these coolers have a round structure (US 35 37 514). Lengthwise grooves are used as the capillary structure. These round coolers must be connected to a flat carrier on which the components to be cooled are located. These carriers yield additional heat transfer or thermal resistance.

Furthermore, it is also known to have a flat design for this cooler (US 56 42 775). These known coolers consist of a block in which tubular channels are formed. Production is complex and expensive.

Furthermore, it is also known to have a cuboidal cooler (US 4,957,803); its housing consists of a plurality of metal layers stacked on top of one another and connected superficially to one another, which are structured and arranged such that within the body, slots yield crossing channels which are joined to one another at the crossing points. This known design is only suited as a thermal spreader. There are no differing vapor channel and capillary structures. In addition, heat transport over long distances is necessary.

The object of the invention is to devise a cooler with improved properties.

Summary of the Invention

The cooler as claimed in the invention is characterized by a simple and economical production. Transmission of heat energy from the outside, into the vaporization area, into the cooler, or from the condensation area to the outside over a short distance is possible by posts which are located in the area of the capillary structure and which are formed by the metal layers.

Furthermore, the cooler has a vapor channel area or a vapor channel structure with a large flow cross section, yielding optimum cooling output.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is detailed below using the following figures:

Figure 1 shows, in a simplified perspective view, a cooler in the form of a flat, plate-shaped or cuboidal heat pipe;

Figure 2 shows a section along line I - I of Figure 1;

Figures 3 and 4 show other possible embodiments of the cooler of the invention;

Figure 5 shows in an enlarged partial representation, and in a side view, the heat pipe, as claimed in the invention, formed by a stack of several metal layers;

Figures 6 and 7 each show in a simplified view, and in an overhead view, two individual or metal layers for example of copper for the capillary area (Figure 6) and the vapor channel area (Figure 7);

Figure 8 shows, in a partial schematic, a section through the capillary area, or through the vapor area, of Figures 6 and 7;

Figures 9 and 10 show, in an overhead view, structured metal layers for the capillary area, or the capillary structure, (Figure 9) or for the vapor channel area or the vapor channel structure (Figure 10) in another possible embodiment of the invention;

Figures 11 and 12 each show, in a partial representation, the two stacked metal layers of Figure 9 for the capillary area;

Figure 13, in a partial representation, shows an overhead view of a partial structure of the capillary area formed by two successive metal layers of Figures 11 and 12;

Figures 14, 15 and 16 show representations similar to Figures 11, 12 and 13 for the vapor channel area;

Figures 17 and 18 show, in an enlarged partial representation, and in an overhead view, similar to Figures 11 and 12, individual metal layers for the capillary area of another possible embodiment;

Figure 19 shows, in a partial representation, an overhead view of a partial structure of the capillary area formed by two successive metal layers of Figures 17 and 18;

Figures 20, 21 and 22 show representations similar to Figures 17, 18 and 19, but for the vapor channel area;

Figure 22 shows the two layers of Figures 20 and 21 on top of one another for forming the vapor channel area;

Figure 23 shows, in the representation of Figure 1, another possible embodiment of the invention;

Figure 24 shows a section along line II-II of Figure 23, for the sake of simplicity only, the capillary area, or the capillary structure being shown;

Figure 25 shows a section along line III-III or IV - IV of Figure 23, for the sake of simplicity only the capillary area or the capillary structure being shown;

Figure 26 shows, in a simplified representation, and in an overhead view, one metal layer for the capillary area;

Figures 27 and 28 each show, in a simplified representation, and in an overhead view, two additional embodiments of one metal layer for the vapor channel area; and

Figure 29 shows, a representation similar to Figure 24, another possible embodiment.

DETAILED DESCRIPTION OF THE INVENTION

In Figures 1 - 22, a heat sink or cooler for dissipating the heat of a heat source is labeled 1. The cooler 1 is built as a heat pipe, but in contrast to the known heat pipe arrangements, the cooler 1 has a very flat plate-shape with flat surfaces on the top and bottom. In the embodiment shown in Figure 1, the cooler 1 is shown in an overhead view with a

rectangular peripheral line, or with the shape of a very flat cuboid, which is rectangular in an overhead view.

Generally the cooling or vaporizer area (first area) is labeled 2, and the second area for heat dissipation, or the condenser area, is labelled 3. The two areas are offset against one another in the lengthwise direction L, of the plate-shaped cooler 1, and on either side of a center plane M, which intersects the cooler 1, and its lengthwise sides vertically. The heat dissipated on the area 2, to the cooler 1 is labelled with an arrow P1, and the heat dissipated by the cooler 1, on area 3, is labelled by an arrow P2. The heat source is formed by the semiconductor power components which are provided on the closed flat top and/or bottom of the cooler 1, on area 2, the flat top and/or bottom being formed by one metal layer 7 (metal foil or plate).

In Figure 2, these semiconductor power components, or chips, which produce heat loss, are labelled 4-6. For electrical insulation on the top and/or bottom of the cooler 1, there is provided, at least in the area of chips 4-6, one ceramic layer 7', which is connected in a suitable manner to the closed metal layer 7, which forms the top and bottom of the cooler.

The inner structure of the cooler 1, and how it works, in general, follow from Figure 2. The inner structure consists of three areas which each extend over the entire cooler, and which are stacked on top of one another, between the top and bottom metal layer 7, more specifically it consists of two outer capillary structures or areas 8, and a middle vapor channel, or vapor channel area, or vapor channel structure 9. The capillary areas 8 are formed by a host of channels which extend between the two areas 2 and 3 and are connected, in at least these areas to the vapor channel or the vapor channel area 9. The vapor channel is a continuous channel which extends over the entire length and width of the cooler 1, or is formed, in the manner detailed below, by a structure of several individual channels, the entire

cross section of the vapor channel being much larger compared to the overall cross section of the capillary areas 8.

The interior of the cooler 1 is partially filled with a coolant which vaporizes when heated. In the simplest case water, also in mixture with an additive, for example, methanol, is suited as the coolant.

How the cooler 1 works is based on the fact that the heat which has flowed onto the area 2 vaporizes the coolant there within the cooler and the vapor then flows in the vapor channel 9 from the area 2 in the direction to the area 3, i.e. in the direction of the arrow A of Figure 2. On the area 3, the heat is dissipated to the outside according to arrow P2. This leads to condensation of the coolant, which as condensate travels into the capillary areas 8, and from there under capillary action flows back opposite the arrow A of Figure 2 on the area 2, where then again vaporization of the medium takes place by the absorbed heat P1, etc. The cooler 1, with reference to the vaporizable coolant provided in the interior of this cooler, forms a closed system, as is inherently known of heat pipe systems.

Figure 3 shows again in a simplified representation, the cooler 1, and on the area 3, cooling elements, or cooling sheets 10, being provided on the outside, which with a large surface cause dissipation of the heat to the outside according to arrow P2, and through or around, by an air stream generated by fan flows.

Figure 4 shows in a similar representation to Figure 3, an auxiliary cooler 11 which is located on the area 3 and through which a coolant or heat-transporting medium of an external cooling system flows, for example, cooling water of an external cooling circuit. This auxiliary cooler 11 can be formed directly on the area 3 of the cooler 1 by several metal layers which are stacked on top of one another and which are joined superficially to one another and in the housing of the auxiliary cooler 11 form internal, closed cooling channels through which the external coolant flows. In particular, it is possible to

form the auxiliary cooler 11 as a so-called microcooler, as is described for example in DE 197 10 783.

As is indicated in Figure 5 with 12 and 13, the cooler 1 is formed by a plurality of metal layers, for example copper layers or plates, or cutouts from a copper foil, which are structured such that within the cooler 1 between these layers, and/or through these layers, the capillary structures 8 through the metal layers 12, and vapor structures 9 through the metal layers 13, with the corresponding channels which extend at least in the lengthwise direction L result.

Figures 6 - 22 show different embodiments for the cooler 1 which differ essentially only by the different structuring of the metal layers 12 and 13.

According to the embodiment of Figures 6 - 8, to form the capillary structures 8 metal layers 12a and 12b are used which are each provided with a plurality of continuous parallel slots, the slots 14a in the metal layers 12a extending transversely to the lengthwise direction L and the slots 14b in the metal layers 12b extending in the lengthwise direction L.

For the vapor area, or the vapor channel structure 9, there are metal layers 13a and 13b, which in turn have slots 15a and 15b, which correspond to slots 14, and slots 15a in the metal layer 13a perpendicular to the lengthwise axis L and slots 15b in the metal layer 13b in the lengthwise direction L. The design is such that the axial distance of two adjacent slots 14a and 14b is the same not only on the metal layers 12a and 12b, but is also equal to the axial distance of two slots 15a and 15b on the metal layers 13a and 13b. In any case, the width of the slots 15a and 15b is roughly 1.5 - 10 times greater than the width of the slots 14a and 14b. Furthermore, the thickness of the metal layers 13a and 13b, is roughly 1 - 3 times the thickness of the metal layers 12a and 12b.

The stacking of the metal layers 12a and 12b forms capillary structures 8 with crossing channels, which are connected to one another, at the crossing points, and which are

formed by the slots 14a and 14b. Likewise, by stacking the metal layers 13a and 13b on top of one another, a vapor structure 9 is achieved with crossing channels, which are connected to one another at the crossing points, formed by the slots 15a and 15b. This approach results in that after joining the metal layers by the latter within the body of the cooler 1 produced in this way, continuous post-like areas 16 are formed, which extend from the top metal layer 7, which tightly seals the upper capillary area 8, as far as the lower metal layer 7, which tightly seals the lower capillary area 8, and which deliver the necessary strength for the cooler 1, and also ensure optimum heat conduction into and out of the cooler 1. These post-like structures 16 are indicated in Figure 5 with a broken line.

The metal layers 12 and 13, can also be structured differently to form structures 8 and 9. Another example is shown in Figures 9 - 16. Figure 9 shows a structured metal layer 12c for the capillary structures 8. This metal layer 12c is provided in its middle area, i.e. within a closed edge area 17, in the manner of screen with a plurality of openings 18 which are each made hexagonal and which adjoin one another similarly to a honeycomb structure. These openings 18 are each formed by crosspieces 19, which pass into one another and which surround each opening 18 in the form of a hexagonal ring structure. On the edge area 17 the openings 18 are only partially formed.

On three corners of the hexagonal ring structure of each opening 18, the crosspieces 19 form an island 20 with an enlarged area, i.e. in the embodiment shown with a circular surface. The islands 20 are distributed such that on each opening 18, in an assumed peripheral direction one corner with an island 20, follows one corner without one such island 20. Furthermore, the structuring is chosen such that two crosspieces 19 of each opening 18, lie parallel to the lengthwise axis L, of the rectangular metal layer 12c, and in one axial direction parallel to the lengthwise axis L one island 20, is followed by an opening 18, one corner point without an island, one crosspiece

19 which extends in the direction of the lengthwise axis L, and then a new island 20, etc.

Furthermore, structuring of the metal layer 12c is not completely symmetrical to a center axis which runs perpendicularly to the lengthwise axis L, but the openings 18 are offset relative to the center axis such that it does not intersect the crosspieces 19, which run parallel to the lengthwise axis L, but intersects the islands. In this way, to form the capillary structures 8, it is possible to provide in alternation, one metal layer 12c in the form shown in Figure 9, as a layer N (Figure 11), and as the subsequent layer N + 1, one metal layer 12c in a layer turned around the center axis (Figure 12), following one another in order to obtain the structure shown in Figure 13 in which the islands 20 of these layers N and (N + 1) lie on one another, while in the middle of each opening 18, of one layer, there is an area of the adjacent layer on which three crosspieces 19 meet one another without an island 20, as is shown in Figure 13. With the described structuring of the metal layers 12c therefore using the same metal layers, very finely structured capillary areas 8 with channels widely branched in all three solid axes can be produced simply by turning every other layer.

Figure 10 shows a representation like Figure 9, with a metal layer 13c for producing the vapor channel structure 9. The metal layer 13c in its structuring corresponds to the metal layer 12c, and differs from it simply in that some of the crosspieces 19, which run transversely to the lengthwise axis L, were omitted, such that the remaining crosspieces 19, together with the islands 20, form zig-zag band-like structures 21', which extend in the lengthwise direction L, with passages 21, which lie in between and which extend in the lengthwise direction. According to Figure 16, the vapor channel area 9 is formed by at least two metal layers 13c being stacked on top of one another, and connected to one another, such that every other metal layer 13c is turned around the center axis so that also in the vapor area 9, the islands 20 of the individual layers 13c, come to rest

on one another and in this way form continuous, post-like structures 16. The passages 21 yield flow channels with larger effective flow cross section for the vapor area 9.

Figures 17 - 22 show as further embodiments, metal layers 12d for forming the capillary structures 8, and the metal layers 13d, for forming the vapor channel structure 9. Figures 17 and 18 in turn show the same metal layer 12d, but Figure 18 in a layer turned around the center axis relative to Figure 17. Likewise, figures 20 and 21 show the same metal layer 13d, but in Figure 21 in a layer turned around the center axis relative to Figure 20.

The metal layer 12d is structured in the manner of the screen within the closed edge area 17, with a plurality of angled openings 22 which are oriented with the angle bisector of their angle segments parallel to the lengthwise axis L.

To form the respective capillary structure 8, at least one metal layer 12 in an unturned form and one metal layer 12 in a turned form, are placed on top of one another, and are connected to one another, such that then the partially overlapping openings yield passages 23, via which the channels formed by the openings 22, in the individual layer, are joined to one another, into a widely branched channel structure, and in addition, post-like areas 16 result.

As Figures 17 and 18 show, the openings 22 are each located in several rows which follow one another in the direction of this lengthwise axis and which run perpendicular to the lengthwise axis L, the openings 22 each being offset from row to row on gaps.

The metal layer 13d, shown in Figures 20 and 22, differs from the metal layers 12d, simply in that, in addition to the openings 22, there are continuous openings which are bordered on the end by the edge area 17, and which extend in the lengthwise direction L, such that in turn band-like structures 24' result, which extend in the lengthwise direction and which also have openings 22. By placing one unturned metal layer 13d,

and one turned metal layer 13d, on top of one another on the band-like structures, additional channels are formed which are connected to one another via the passages 23, and also the post-like areas 16, which adjoin the areas 16 in the capillary areas 8 and are added to the continuous posts 16 between the metal layers 7.

Figure 23 is another representation according to Figure 1. Figure 23 shows a cooler 1a in the form of a heat pipe. In this embodiment, the cooler 1a, or its body, is in turn formed from several copper or metal layers which are joined to one another lying stacked one top of one another to the cooler 1a. The metal layers 12e for the capillary areas 8 are made such that they are each provided on one surface side with several groove-like depressions 25 which extend in the lengthwise direction and which are produced by etching, stamping, or by machining which removes material or shavings, or in some other way. The depressions 25 each end in a continuous opening 26, which is provided at a distance from a closed edge area. The metal layers 12e are then turned alternatingly to form the capillary areas 8, and are placed unturned on top of one another such that each depression 25 of one layer 12e is added to one depression 25 of the adjacent layer 12e to form a channel, as is shown in Figure 24. On the two ends, or areas 2 and 3, these channels then empty according to Figure 25, into spaces which are formed by openings 26 in the metal layers 12e and via which the channels are connected to the vapor channel 9.

The metal layers 13e, which form the vapor area, or the vapor structure, are made, for example, according to Figure 27, similarly to layers 12e, simply with depressions 27 of greater width and/or depth, or by the fact that according to Figure 28, in the metal layers 13e there is one opening 28 with a large area each.

Figure 29 shows a representation similar to Figure 24. The cooler 1a is disclosed in which the metal layers 12e for forming the capillary structure, are not turned alternatingly,

but are each in the same orientation so that the depressions 25 form especially fine channels.

In the above described embodiments it was assumed that the channels which form the capillary structures are free channels. It is also possible to place an auxiliary material which supports and/or causes a capillary effect in these or other structured or shaped channels, also in channels with large effective cross sections, for example, in the form of a powder, for example in the form of a powder consisting of at least one metal and/or metal oxide, for example copper and/or aluminum and/or copper oxide and/or aluminum oxide, and/or in the form of a powder consisting of at least one ceramic, and/or in the form of a powder from mixtures of the aforementioned substances, as is indicated by 29 in Figure 24.

Copper is suited for the metal layers, the metal layers being joined superficially to one another using DCB technology or active soldering. Aluminum or an aluminum alloy is also suited for the metal layers. In this case, the metal layers are connected to one another by vacuum soldering. The thickness of the metal layers can roughly be between 100 and 1000 microns and the structure widths in the area are between 50 and 1000 microns.

Reference number list

1,1a	cooler
2, 3	area
4 - 6	component
7	metal layer
7'	ceramic layer
8	capillary area
9	vapor channel area
10	cooling element
11	auxiliary cooler
12,12a,12b	metal layer
12c,12d,12e	metal layer
13,13a,13b	metal layer
13c,13d,13e	metal layer
14a, 14b	slot
15a, 15b	slot
16	posts
17	edge area
18	opening
19	crosspiece
20	island
21	opening
21'	structure
22	opening
23	passage
24	opening
24'	structure
25	depression
26	opening
27	depression
28	opening
29	auxiliary material

ABSTRACT OF THE DISCLOSURE

The invention relates to a novel design of a cooler in the form of a heat pipe, with a housing in which an interior space closed to the cutside is formed to hold a liquid, vaporizable coolant or heat-transport medium.

Fig.1

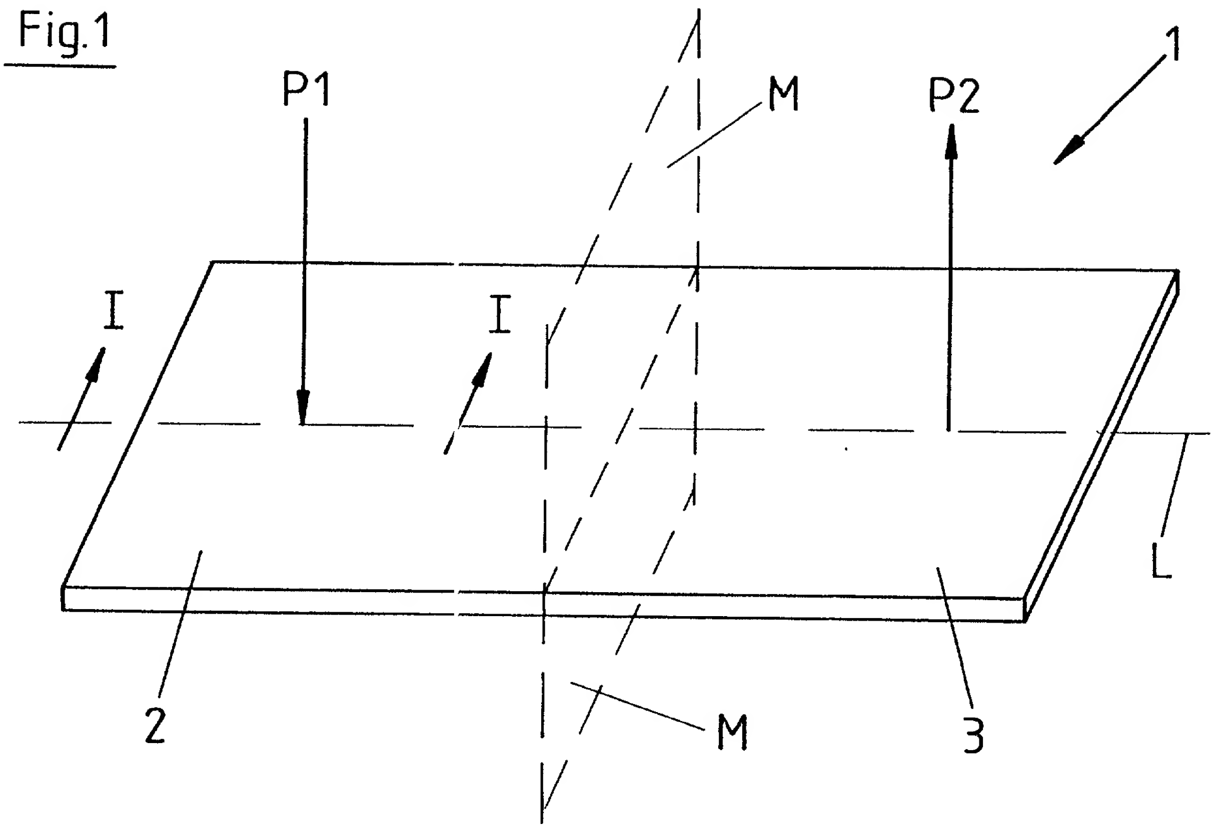


Fig.2

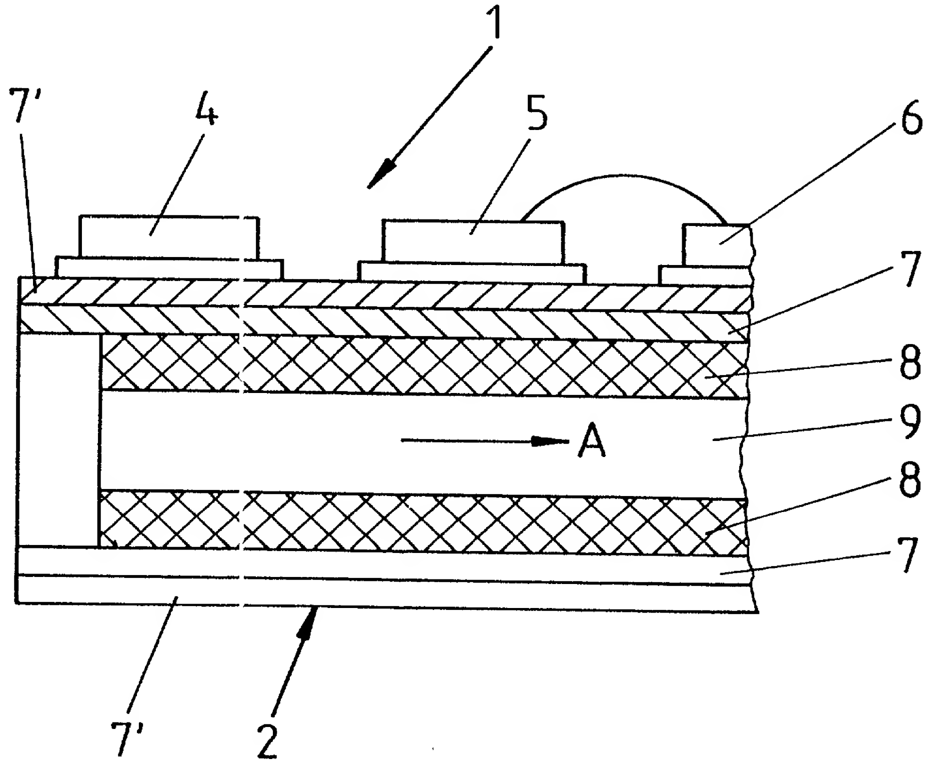


Fig.3

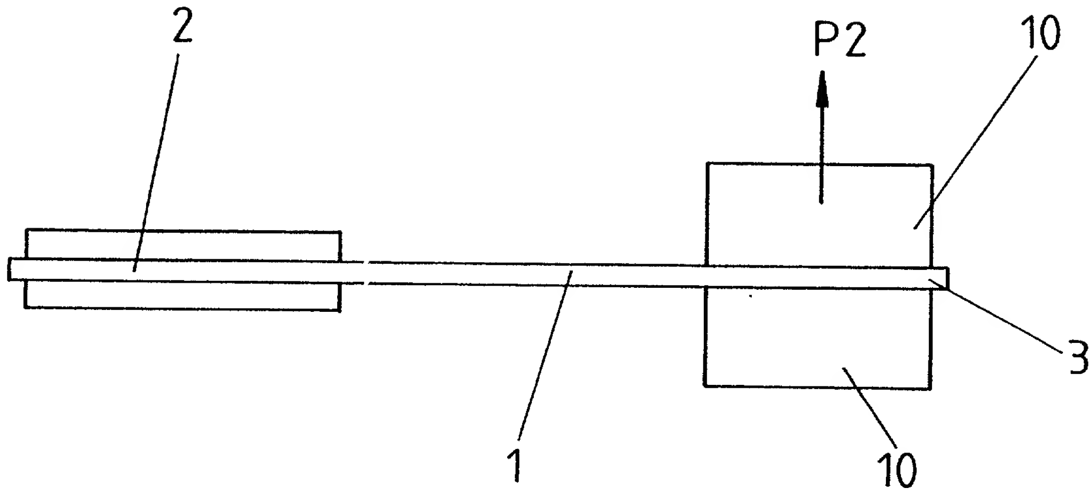


Fig.4

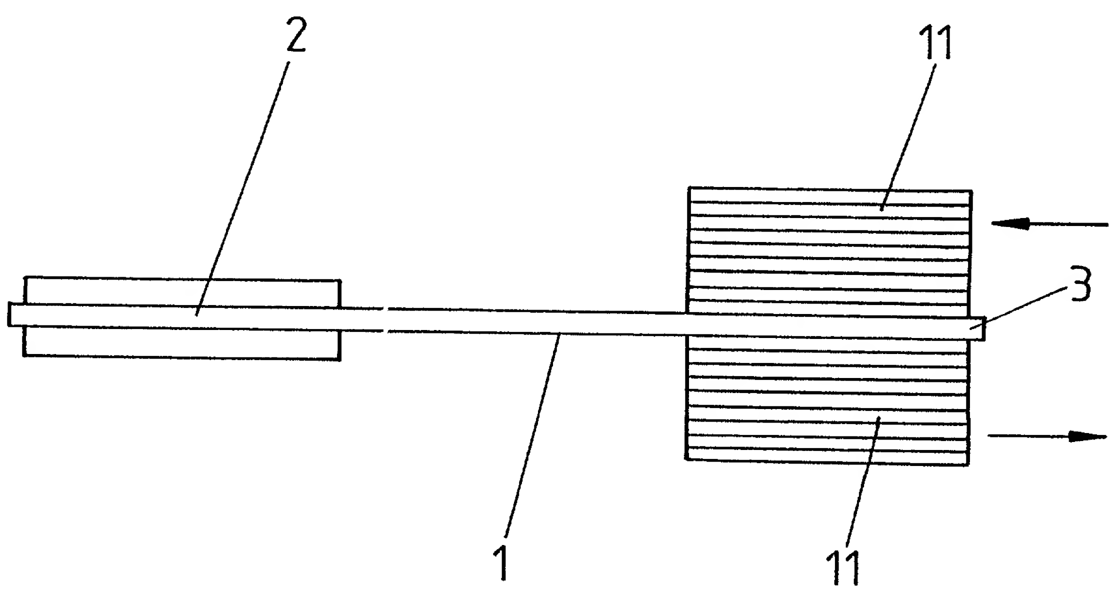


Fig. 5

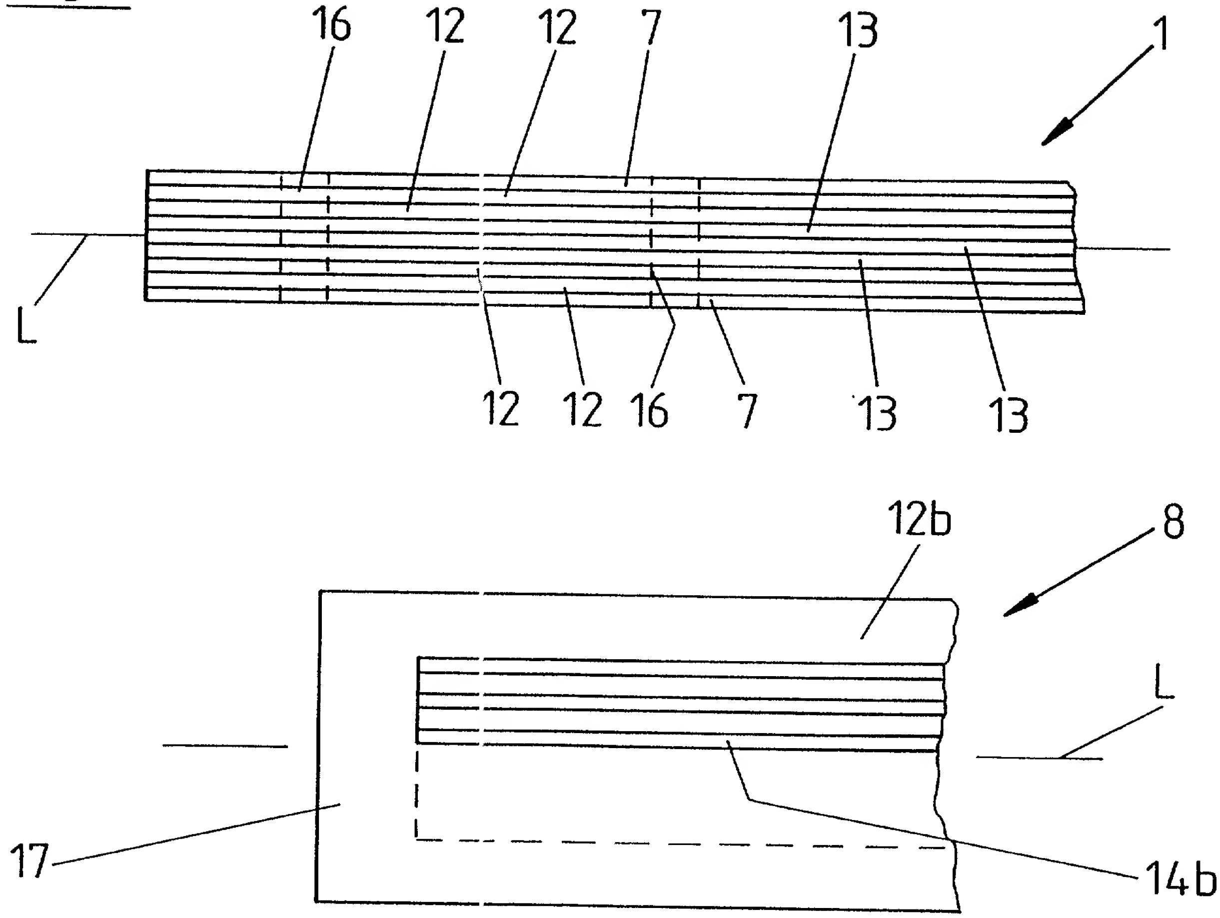


Fig. 6

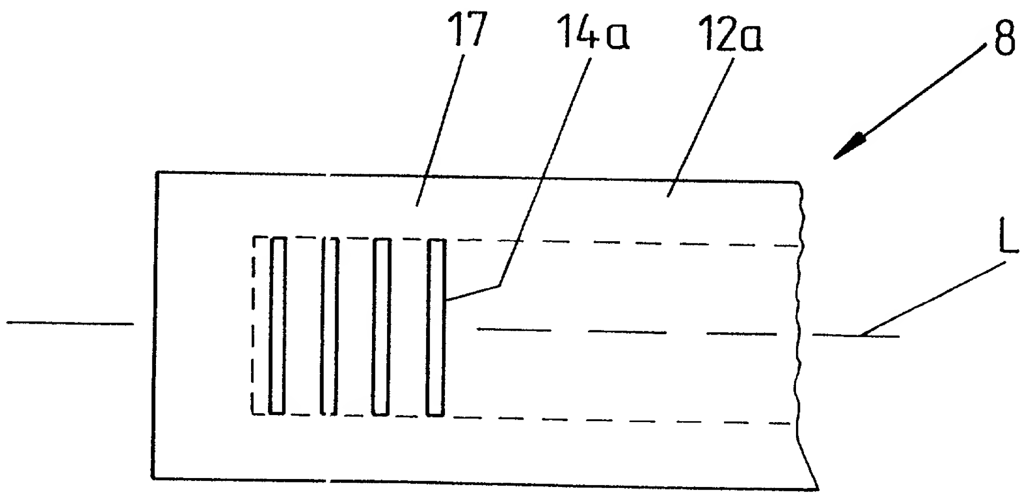


Fig. 7

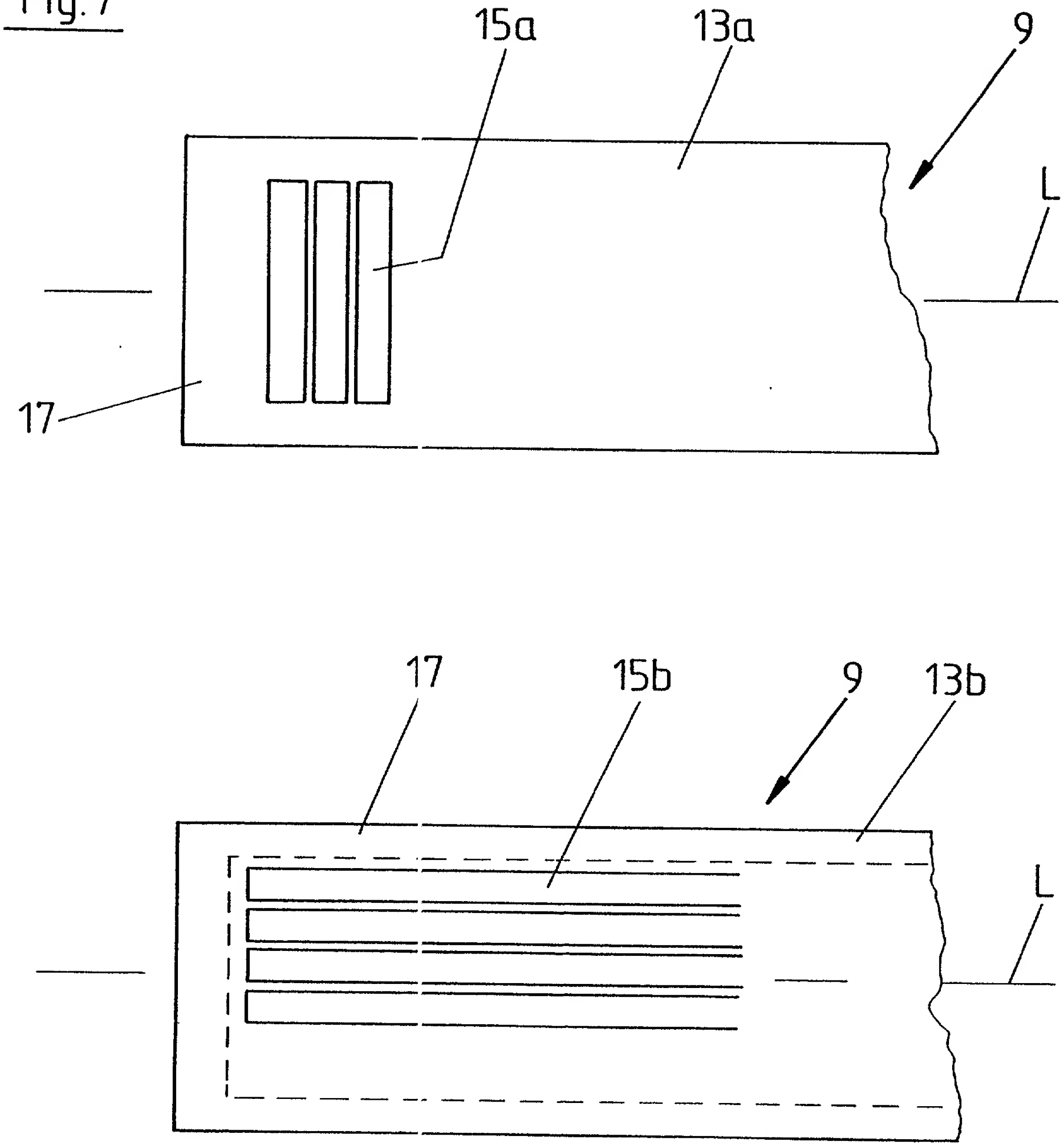


Fig. 8

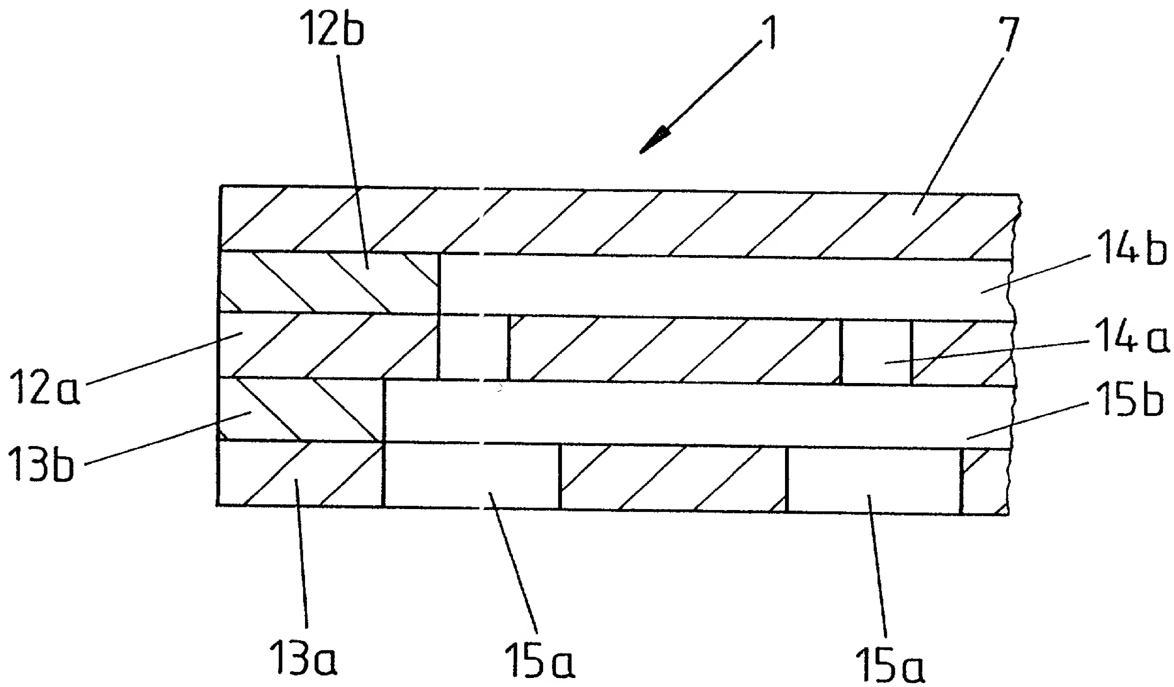


Fig. 9

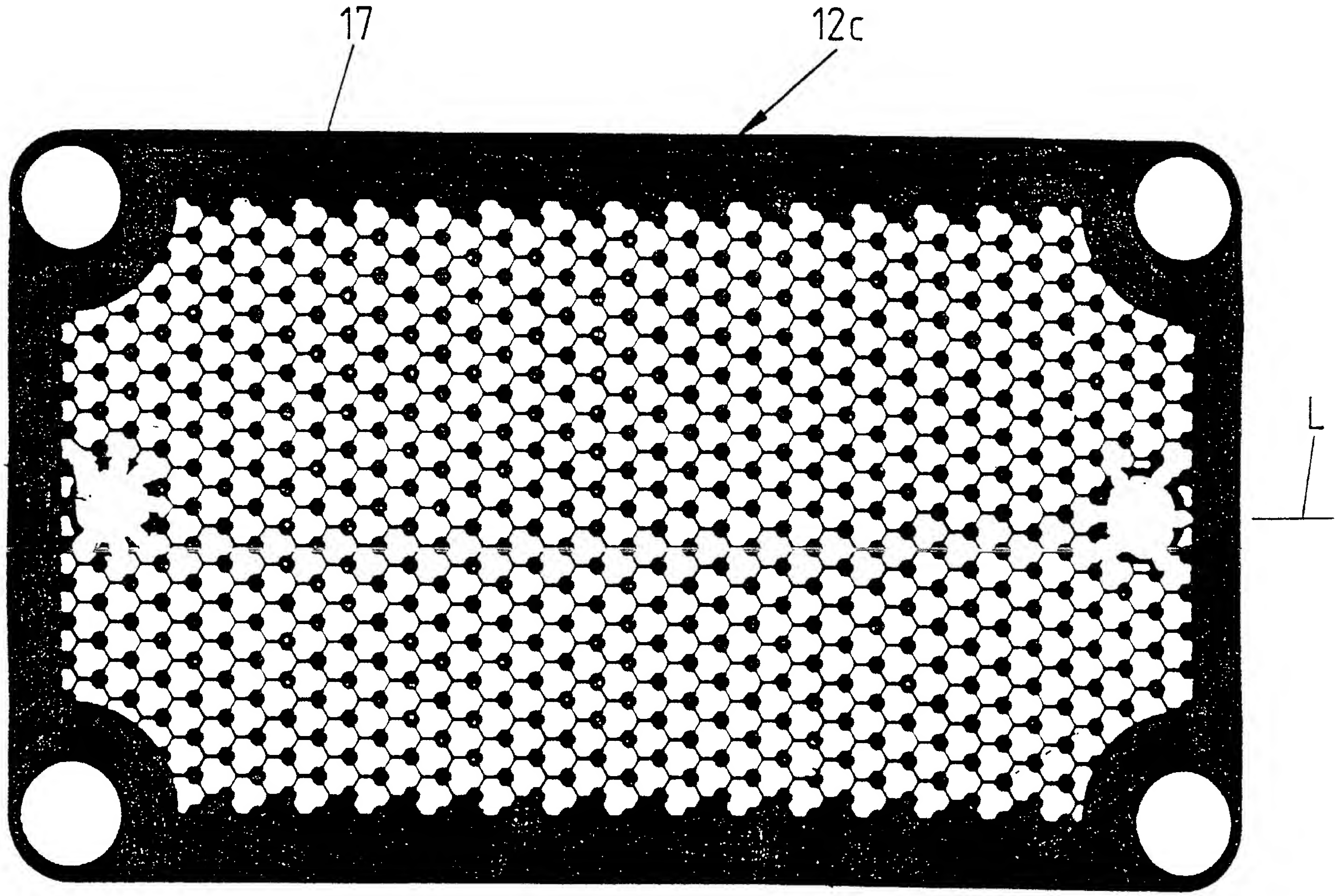


Fig. 10

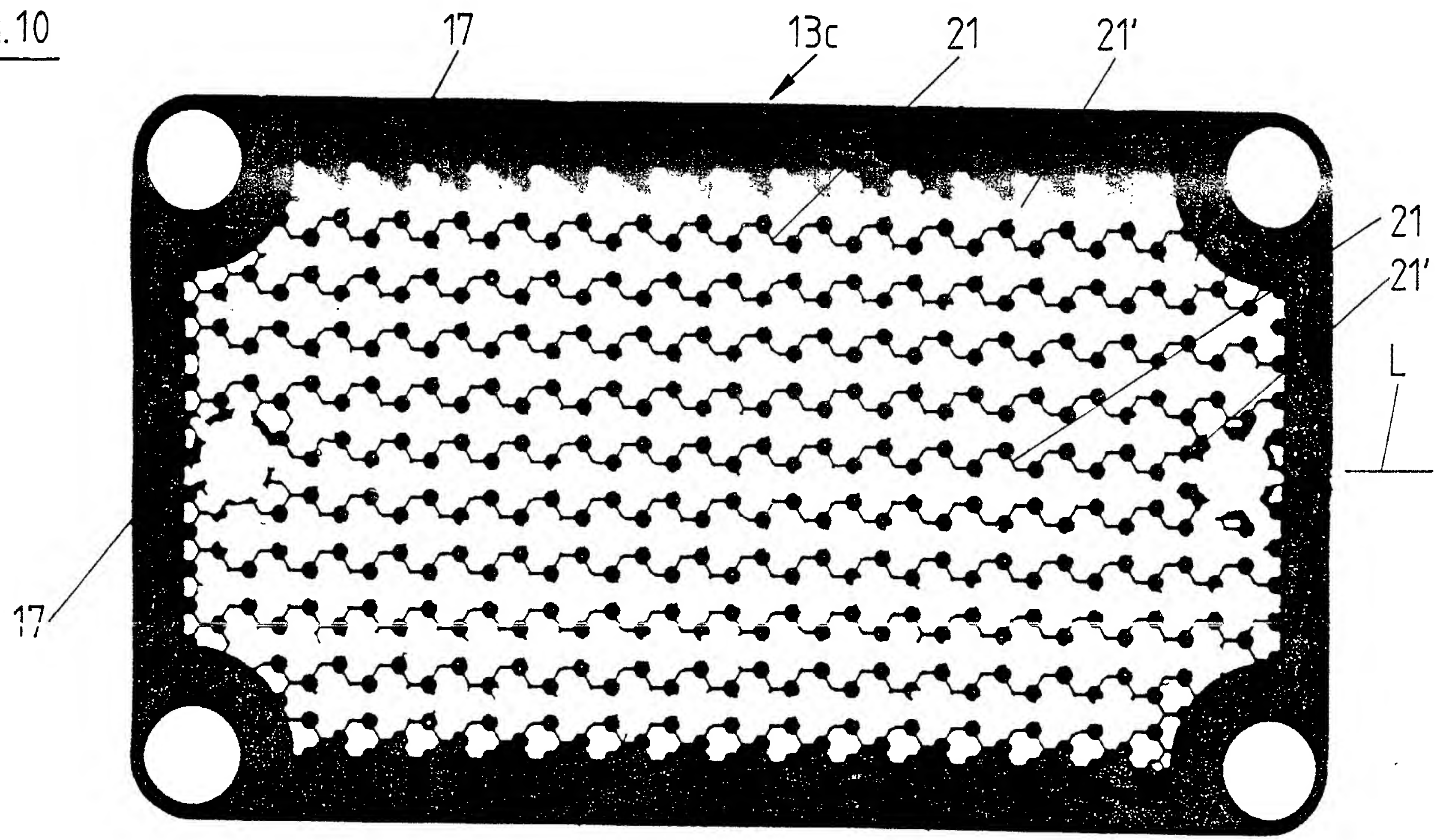


Fig.11

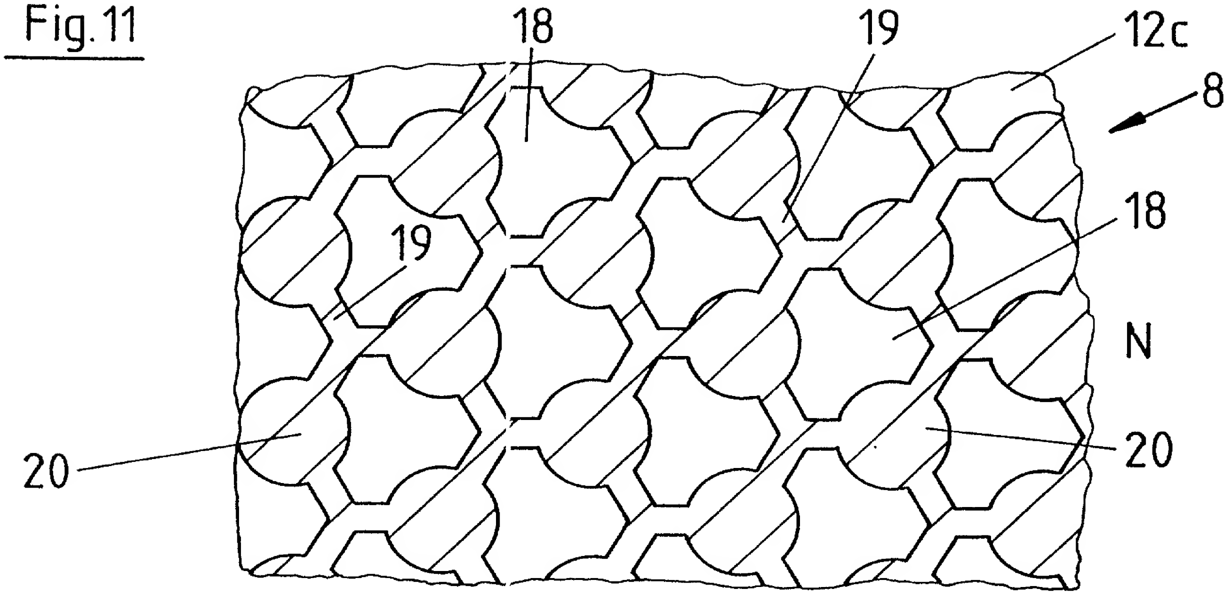


Fig.12

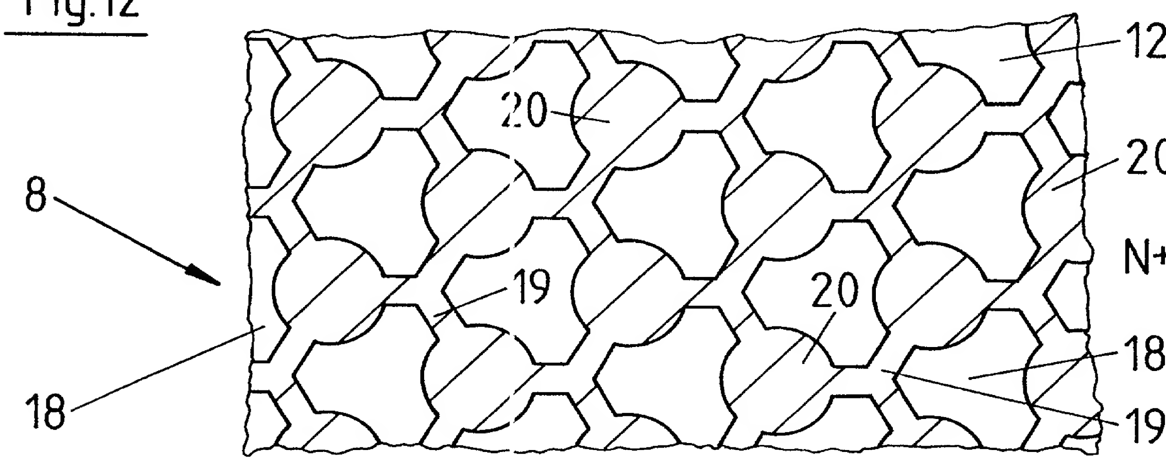


Fig.13

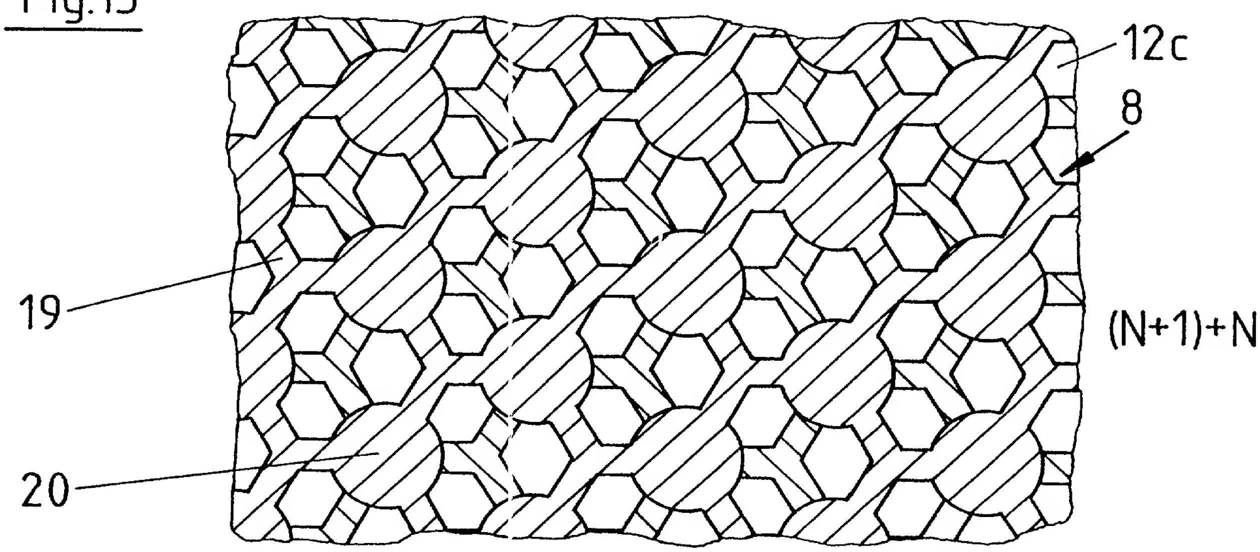


Fig.14

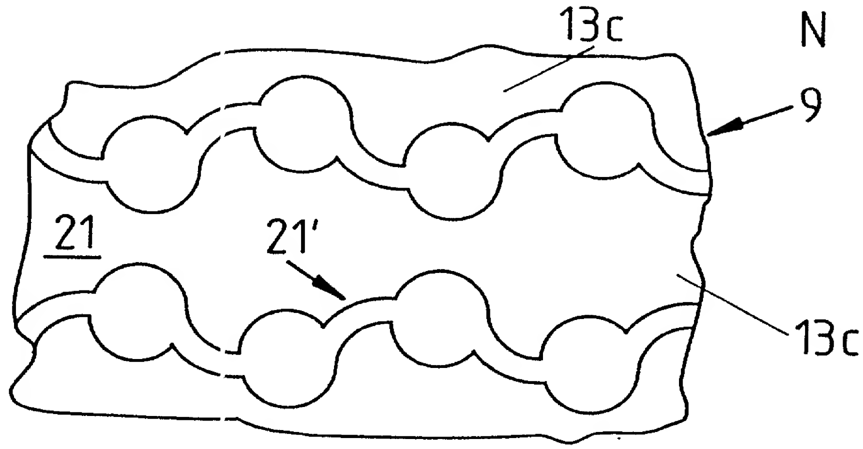


Fig.15

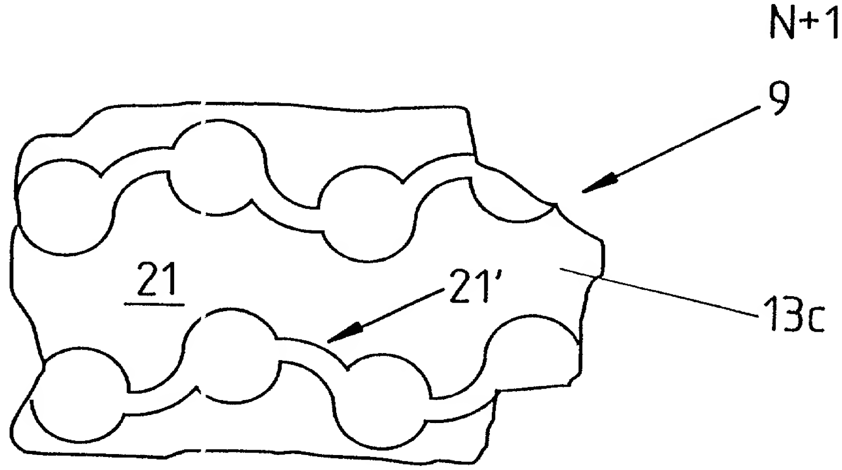


Fig.16

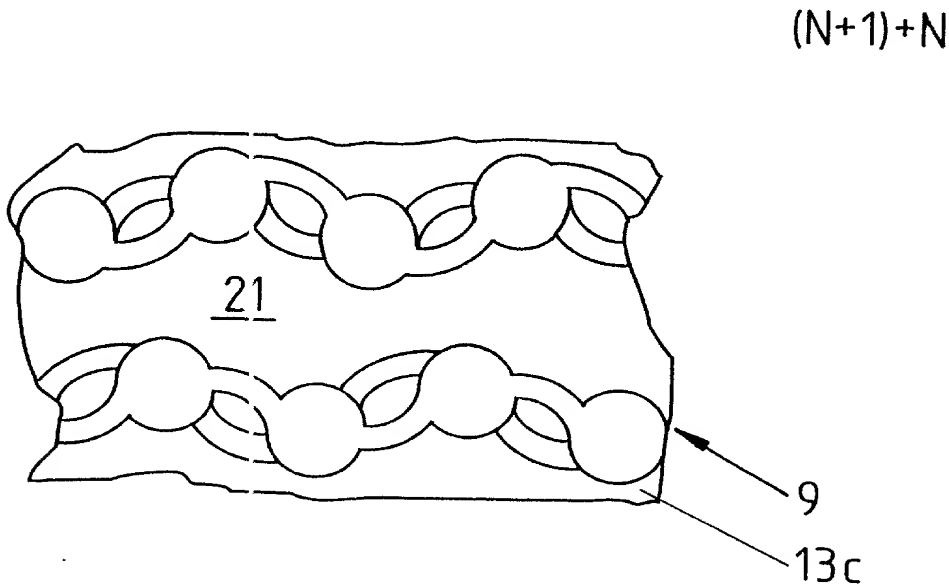


Fig.17

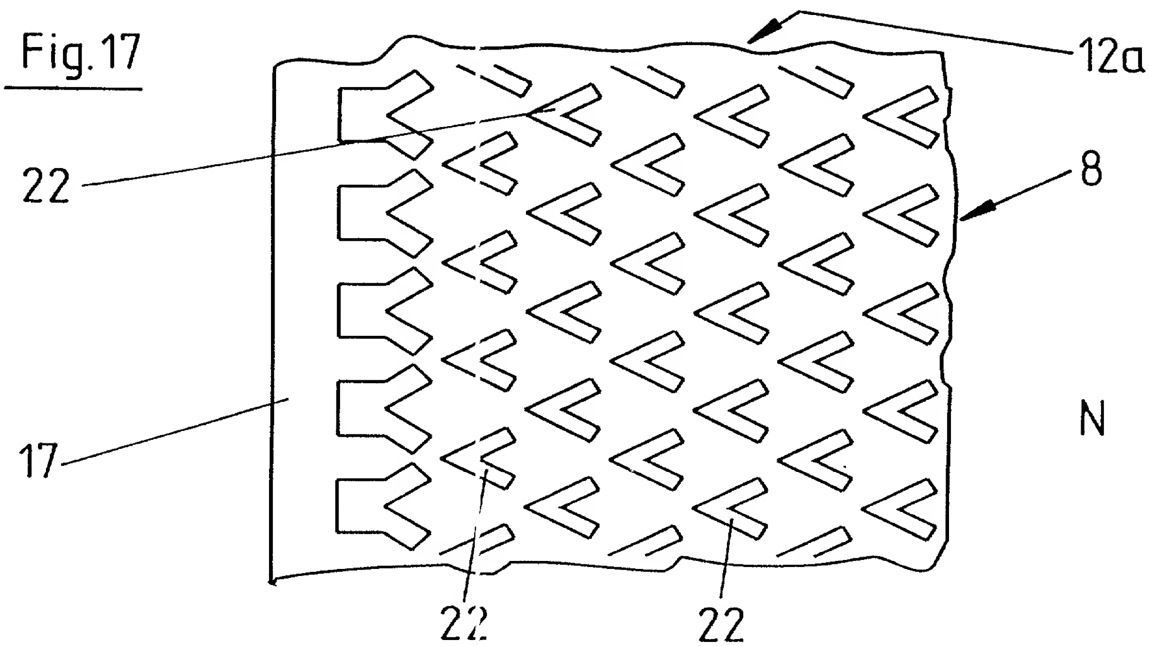


Fig.18

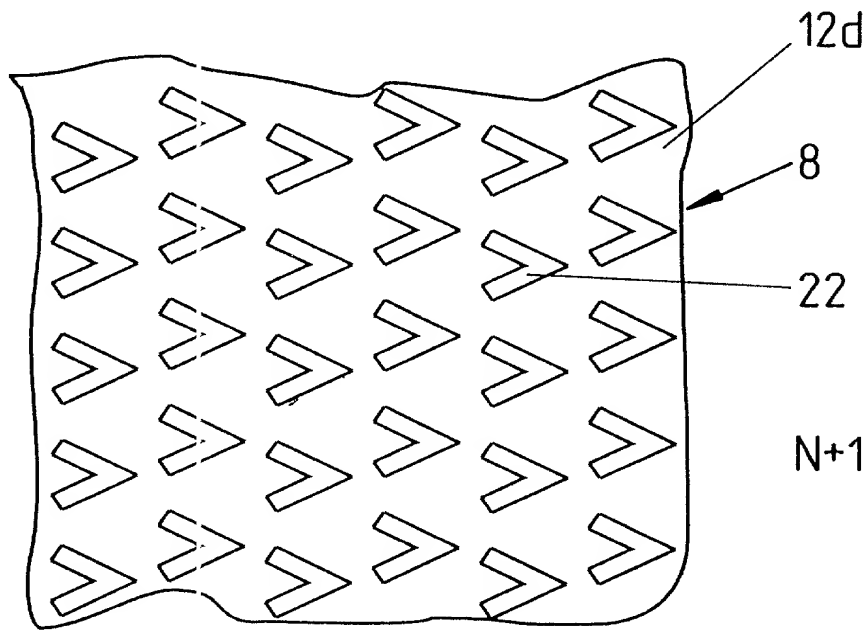


Fig.19

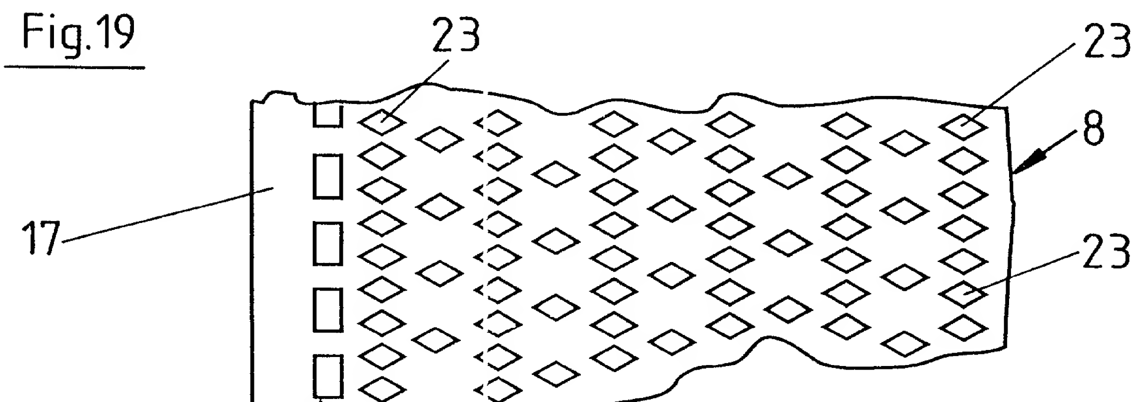


Fig. 20

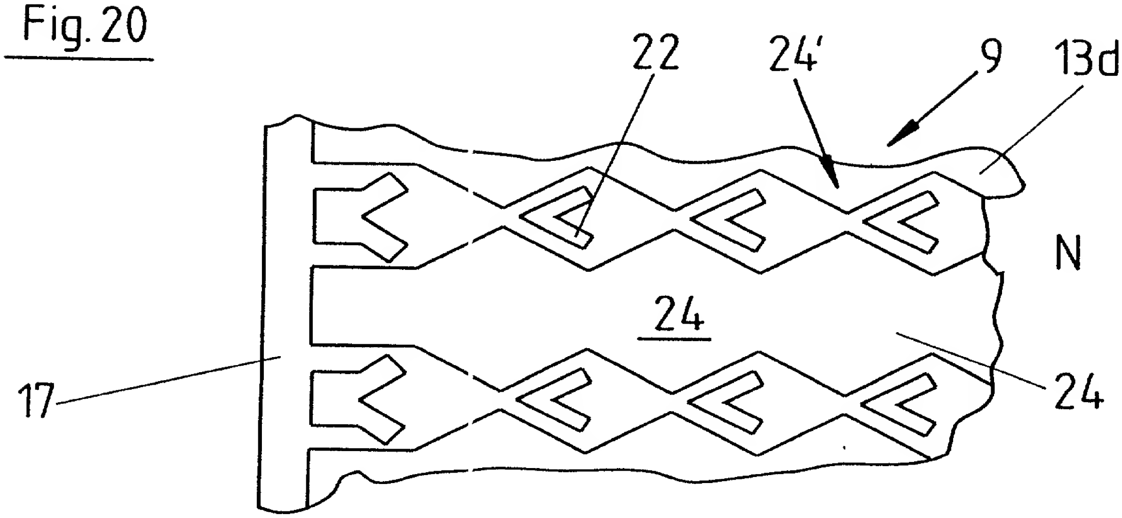


Fig. 21

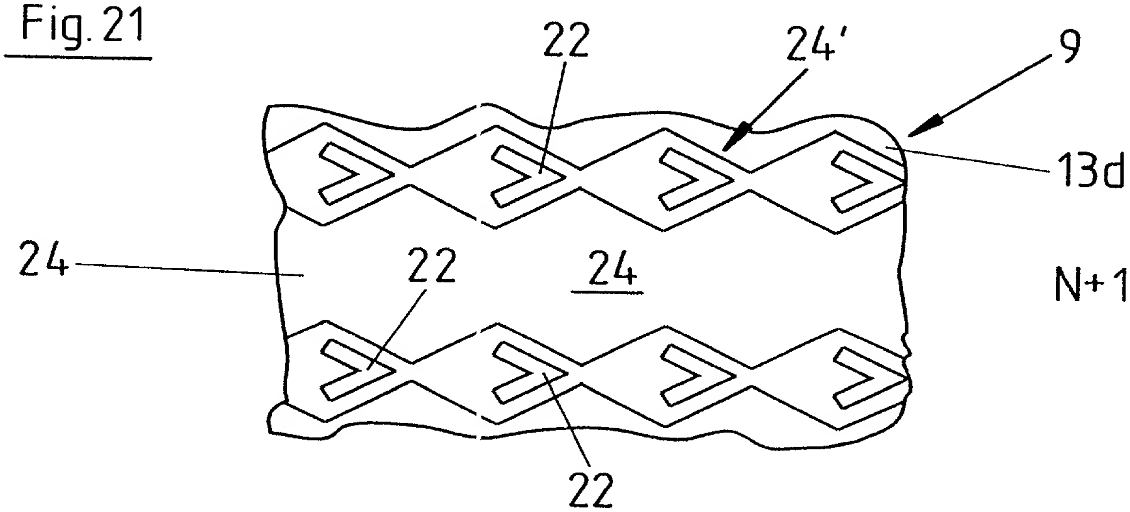


Fig. 22

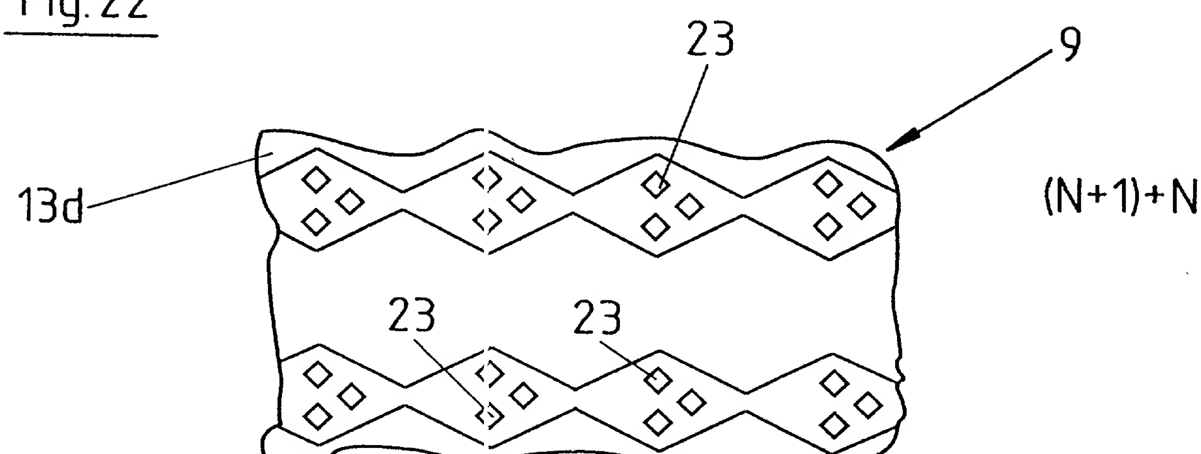


Fig. 23

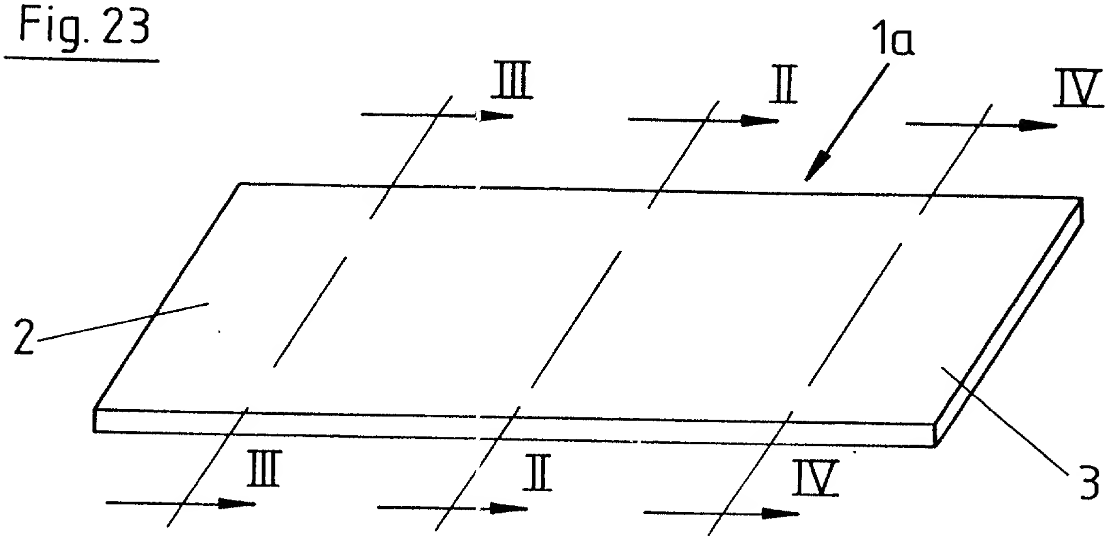


Fig. 24

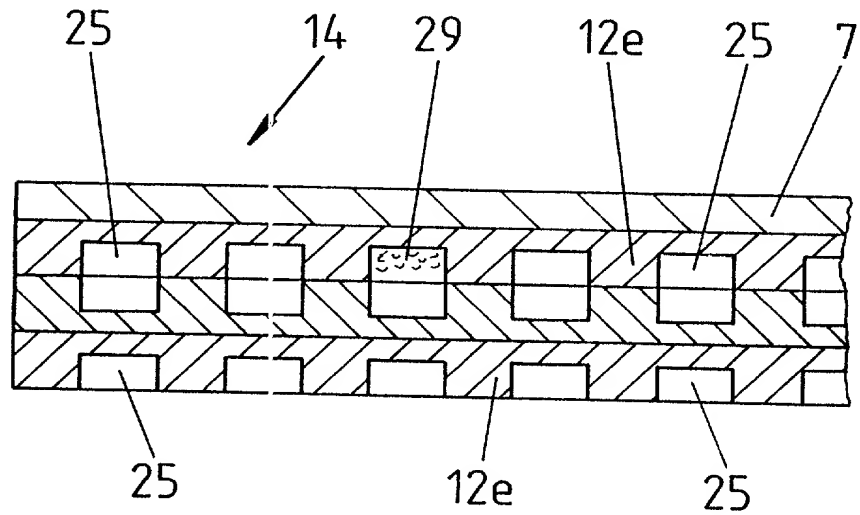


Fig. 25

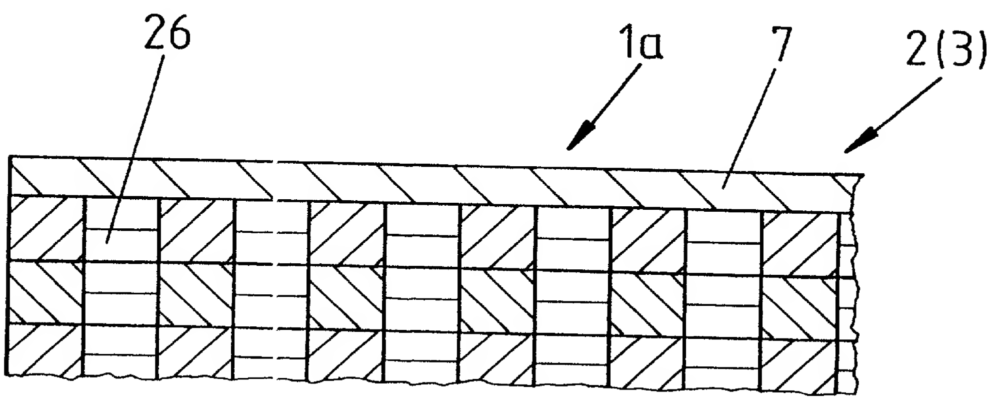


Fig. 26

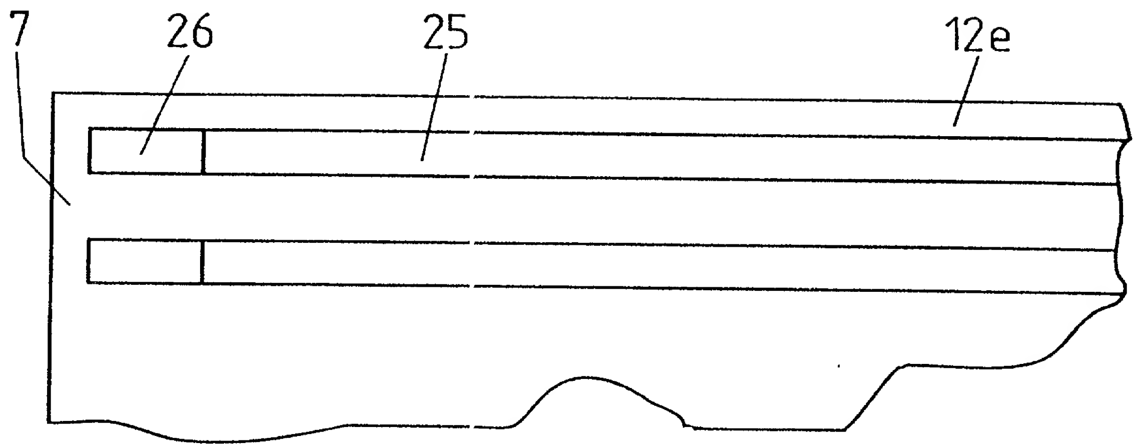


Fig. 28

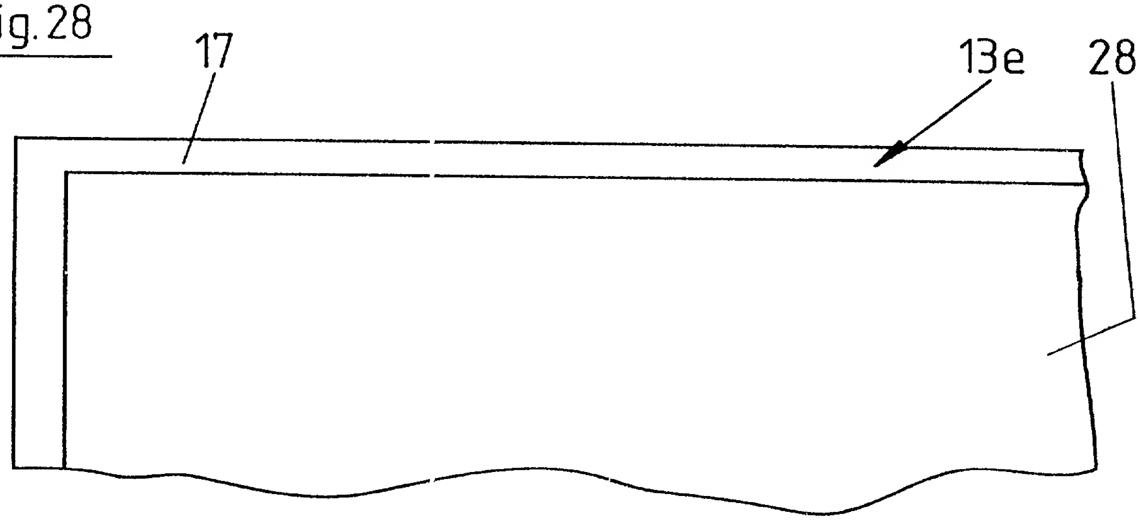


Fig. 27

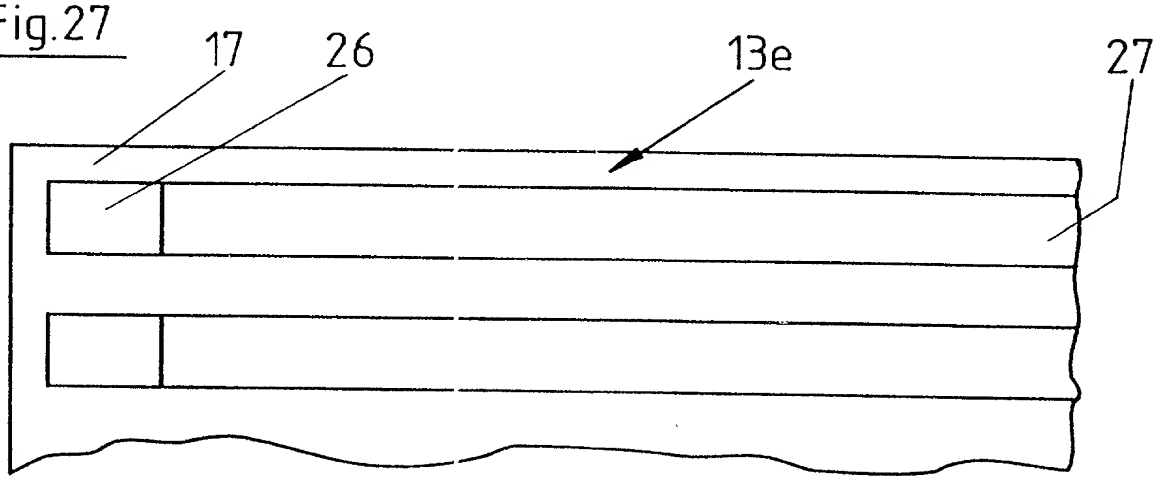
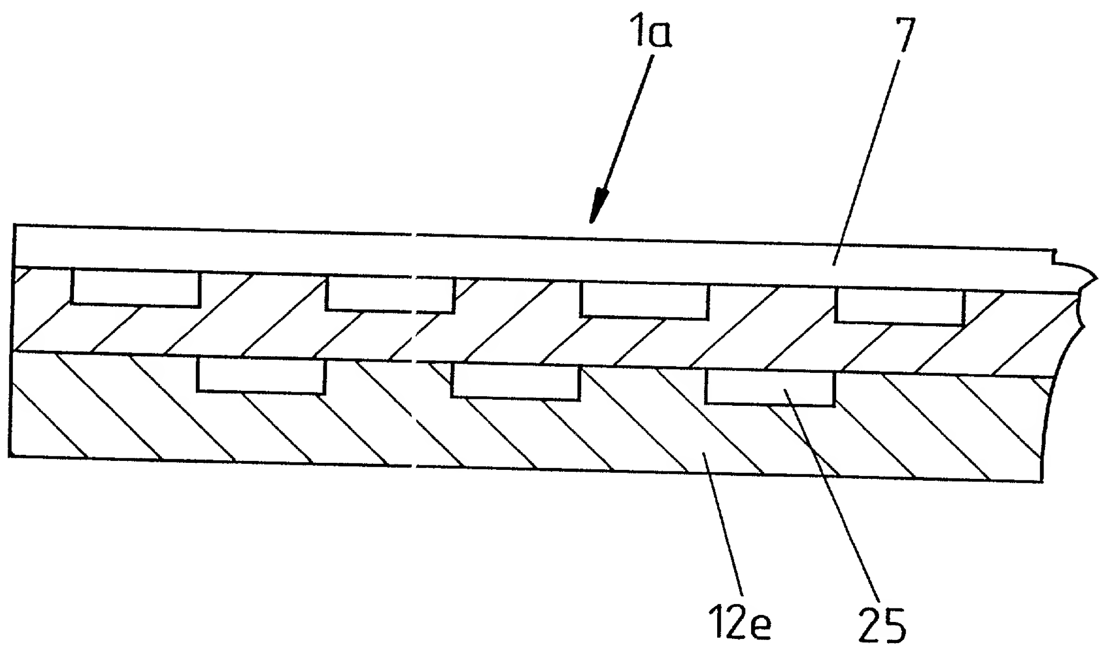


Fig. 29



A Cooler~~, especially~~ for electrical components

Background of the Invention

The invention relates to a cooler, ~~especially~~ in particular, a cooler for electrical components, in the form of a ~~so-called~~ heat pipe.

Coolers of this type are fundamentally known and are based on the principle of vaporization and condensation of a coolant, or heat transport medium, housed in the closed interior of the cooler. Generally these coolers have a round structure (US 35 37 514). Lengthwise grooves are used as the capillary structure. These round coolers must be connected to a flat carrier on which ~~then~~ the components to be cooled are located. These carriers yield additional heat transfer or thermal resistance.

Furthermore, it is also known to have a flat design ~~is also known~~ for this cooler (US 56 42 775). These known coolers consist of a block in which tubular channels are formed. Production is complex and expensive.

Furthermore, it is also known to have a cuboidal cooler ~~is known~~ (US 49 57 803); its housing consists of a plurality of metal layers stacked on top of one another and connected superficially to one another, which are structured and arranged such that within the body, slots yield crossing channels which are joined to one another at the crossing points. This known design is only suited as a thermal spreader. There are no differing vapor channel and capillary structures. In addition, heat transport over long distances is necessary.

The object of the invention is to devise a cooler with improved properties. ~~To do this a cooler is made as claimed in claim 1.~~

SUMMARY OF THE INVENTION

The cooler as claimed in the invention is characterized by ~~the possibility of~~ a simple and economical production. Transmission of heat energy from the outside, into the vaporization area, into the cooler, or from the condensation area to the outside over a short distance is possible by posts which are located ~~especially~~ in the area of the capillary structure and which are formed by the metal layers. Furthermore, The cooler ~~as claimed in the invention furthermore~~ has a vapor channel area or a vapor channel structure with a large flow cross section, yielding optimum cooling output.

~~Developments of the~~ invention are ~~the subject matter of the dependent claims~~.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is detailed below using the following figures~~ on embodiments~~.

Figure 1 shows, in a simplified perspective view, a cooler in the form of a flat, plate-shaped or cuboidal heat pipe;

Figure 2 shows a section along line I - I of Figure 1;

Figures 3 and 4 show other possible embodiments of the cooler of the invention;

Figure 5 shows, in an enlarged partial representation, and in a side view, the heat pipe, as claimed in the invention, formed by a stack of several metal layers;

Figures 6 and 7 each show in a simplified view, and in an overhead view, two individual, or metal layers, for example of copper for the capillary area (Figure 6) and the vapor channel area (Figure 7);

Figure 8 shows, in a partial schematic, a section through the capillary area, or through the vapor area, of Figures 6 and 7;

Figures 9 and 10 show, in an overhead view, structured metal layers for the capillary area, or the capillary structure, (Figure 9) or for the vapor channel area or the vapor channel structure (Figure 10) in another possible embodiment of the invention;

Figures 11 and 12 each show, in a partial representation, the two stacked metal layers of Figure 9 for the capillary area;

Figure 13, in a partial representation, shows an overhead view of a partial structure of the capillary area formed by two successive metal layers of Figures 11 and 12;

Figures 14, 15 and 16 show representations similar to Figures 11, 12 and 13 for the vapor channel area;

Figures 17 and 18 show, in an enlarged partial representation, and in an overhead view, similar to Figures 11 and 12, individual metal layers for the capillary area of another possible embodiment;

Figure 19 shows, in a partial representation, an overhead view of a partial structure of the capillary area formed by two successive metal layers of Figures 17 and 18;

Figures 20, 21 and 22 show representations similar to Figures 17, 18 and 19, but for the vapor channel area;

Figure 22 shows the two layers of Figures 20 and 21 on top of one another for forming the vapor channel area;

Figure 23 shows, in the representation of Figure 1, another possible embodiment of the invention;

Figure 24 shows, a section along line II-II of Figure 23, for the sake of simplicity, only, the capillary area, or the capillary structure being shown;

Figure 25 shows a section along line III-III or IV - IV of Figure 23, for the sake of simplicity, only, the capillary area or the capillary structure being shown;

Figure 26 shows, in a simplified representation, and in an overhead view, one metal layer for the capillary area;

Figures 27 and 28 each show, in a simplified representation, and in an overhead view, two additional embodiments of one metal layer for the vapor channel area; and

Figure 29 shows, a representation similar to Figure 24, ~~in~~ another possible embodiment.

DETAILED DESCRIPTION OF THE INVENTION

In Figures 1 - 22, a heat sink or cooler for dissipating the heat of a heat source is labeled 1. The cooler 1 is built as a ~~so-called~~ heat pipe, but in contrast to the known heat pipe arrangements, the cooler 1 has a very flat plate-shape with flat surfaces on the top and bottom. In the embodiment shown in Figure 1, the cooler 1 is shown ~~produced~~ in an overhead view with a rectangular peripheral line, or with the shape of a very flat cuboid, which is rectangular in an overhead view.

Generally the cooling or vaporizer area (first area) is labeled 2, and the second area for heat dissipation, or the condenser area, is labelled 3. The two areas are offset against one another in the lengthwise direction L, of the plate-shaped cooler 1, and on either side of a center plane M, which intersects the cooler 1, and its lengthwise sides vertically. The heat

dissipated on the area 2, to the cooler 1, is labelled with an arrow P1, and the heat dissipated by the cooler, on area 3, is labelled by an arrow P2. The heat source is ~~for example~~ formed by the semiconductor power components which are provided on the closed flat top and/or bottom of the cooler 1, on area 2, the flat top and/or bottom being formed by one metal layer 7 (metal foil or plate).

In Figure 2, these semiconductor power components, or chips, which produce heat loss, are labelled 4-6. For electrical insulation on the top and/or bottom of the cooler 1, there is provided, at least in the area of chips 4-6, one ceramic layer 7', which is connected in a suitable manner to the closed metal layer 7, which forms the top and bottom of the cooler.

The inner structure of the cooler 1, and how it works, in general, follow from Figure 2. The inner structure consists of three areas which each extend over the entire cooler, and which are stacked on top of one another, between the top and bottom metal layer 7, more specifically, it consists of ~~the~~ two outer capillary structures or areas 8, and ~~the~~ a middle vapor channel, or vapor channel area, or vapor channel structure 9. The capillary areas 8 are formed by a host of channels which extend between the two areas 2 and 3 and are connected, in at least ~~in~~ these areas to the vapor channel or the vapor channel area 9. The ~~latter~~ vapor channel is ~~for example~~ a continuous channel which extends over the entire length and width of the cooler 1, or is formed, in the manner detailed below, by a structure of several individual channels, the entire cross section of the

vapor channel ~~however~~ being much larger compared to the overall cross section of the capillary areas 8.

The interior of the cooler 1 is partially filled with a coolant which vaporizes when heated. In the simplest case water, also in mixture with an additive, for example, methanol, is suited as the coolant.

How the cooler 1 works is based on the fact that the heat which has flowed onto the area 2 vaporizes the coolant there within the cooler and the vapor then flows in the vapor channel 9 from the area 2 in the direction to the area 3, i.e. in the direction of the arrow A of Figure 2. On the area 3, the heat is dissipated to the outside according to arrow P2. This leads to condensation of the coolant, which as condensate travels into the capillary areas 8, and from there under capillary action flows back opposite the arrow A of Figure 2 on the area 2, where then again vaporization of the medium takes place by the absorbed heat P1, etc. The cooler 1, ~~therefore~~ with reference to the vaporizable coolant provided in the interior of this cooler, forms a closed system, as is inherently known of heat pipe systems.

Figure 3 shows again in a simplified representation, the cooler 1, and on the area 3, cooling elements, or cooling sheets 10, being provided on the outside, which with a large surface cause dissipation of the heat to the outside according to arrow P2, and through or around, ~~which for example~~ by an air stream generated by ~~a~~ fan flows.

Figure 4 shows in a similar representation to Figure 3, an auxiliary cooler 11 which is located on the area 3 and through

which a coolant or heat-transporting medium of an external cooling system flows, for example, cooling water of an external cooling circuit. This auxiliary cooler 11 can be formed ~~for example~~ directly on the area 3 of the cooler 1 by several metal layers which are stacked on top of one another and which are joined superficially to one another and in the housing of the auxiliary cooler 11 form internal, closed cooling channels through which the external coolant flows. In particular, it is possible to form the auxiliary cooler 11 as a so-called microcooler, as is described for example in DE 197 10 783.

As is indicated in Figure 5 with 12 and 13, the cooler 1 is formed by a plurality of metal layers, for example copper layers or plates, or cutouts from a copper foil, which are structured such that within the cooler 1 between these layers, and/or through these layers, the capillary structures 8 through the metal layers 12, and vapor structures 9 through the metal layers 13, with the corresponding channels which extend at least in the lengthwise direction L result.

Figures 6 - 22 ~~now~~ show different embodiments for the cooler 1 which differ essentially only by the different structuring of the metal layers 12 and 13.

According to the embodiment of Figures 6 - 8, to form the capillary structures 8 metal layers 12a and 12b are used which are each provided with a plurality of continuous parallel slots, the slots 14a in the metal layers 12a extending transversely to the lengthwise direction L and the slots 14b in the metal layers 12b extending in the lengthwise direction L.

For the vapor area, or the vapor channel structure 9, there are metal layers 13a and 13b, which in turn have slots 15a and 15b, which correspond to slots 14, and slots 15a in the metal layer 13a perpendicular to the lengthwise axis L and slots 15b in the metal layer 13b in the lengthwise direction L. The design is such that the axial distance of two adjacent slots 14a and 14b is the same not only on the metal layers 12a and 12b, but is also equal to the axial distance of two slots 15a and 15b on the metal layers 13a and 13b. In any case, the width of the slots 15a and 15b is roughly 1.5 - 10 times greater than the width of the slots 14a and 14b. Furthermore, the thickness of the metal layers 13a and 13b, is roughly 1 - 3 times the thickness of the metal layers 12a and 12b.

The stacking of the metal layers 12a and 12b forms capillary structures 8 with crossing channels, which are connected to one another, at the crossing points, and which are formed by the slots 14a and 14b. Likewise, by stacking the metal layers 13a and 13b on top of one another, a vapor structure 9 is achieved with crossing channels, which are connected to one another at the crossing points, formed by the slots 15a and 15b. This approach ~~furthermore~~ results in that after joining the metal layers by the latter within the body of the cooler 1 produced in this way, continuous post-like areas 16 are formed, which extend from the top metal layer 7, which tightly seals the upper capillary area 8, as far as the lower metal layer 7, which tightly seals the lower capillary area 8, and which deliver the necessary strength for the cooler 1, and ~~especially~~ also ensure optimum heat conduction into

and out of the cooler 1. These post-like structures 16 are indicated in Figure 5 with ~~the~~ a broken line.

~~It goes without saying that~~ The metal layers 12 and 13, can also be structured differently to form structures 8 and 9. Another example is shown in Figures 9 - 16. Figure 9 shows a structured metal layer 12c for the capillary structures 8. This metal layer 12c is provided in its middle area, i.e. within a closed edge area 17, in the manner of screen with a plurality of openings 18 which are each made hexagonal and which adjoin one another similarly to a honeycomb structure. These openings 18 are each formed by crosspieces 19, which pass into one another and which surround each opening 18 in the form of a hexagonal ring structure. On the edge area 17 the openings 18 are ~~then~~ only partially formed.

On three corners of the hexagonal ring structure of each opening 18, the crosspieces 19 form an island 20 with an enlarged area, i.e. in the embodiment shown with a circular surface. The islands 20 are distributed such that on each opening 18, in an assumed peripheral direction one corner with an island 20, follows one corner without one such island 20. Furthermore, the structuring is chosen such that two crosspieces 19 of each opening 18, lie parallel to the lengthwise axis L, of the rectangular metal layer 12c, and in one axial direction parallel to the lengthwise axis L one island 20, is followed by an opening 18, one corner point without an island, one crosspiece 19 which extends in the direction of the lengthwise axis L, and then a new island 20, etc.

Furthermore, structuring of the metal layer 12c is not completely symmetrical to a center axis which runs perpendicularly to the lengthwise axis L, but the openings 18 are offset relative to the center axis such that it does not intersect the crosspieces 19, which run parallel to the lengthwise axis L, but intersects the islands. In this way, to form the capillary structures 8, it is possible to provide in alternation, one metal layer 12c in the form shown in Figure 9, as a layer N (Figure 11), and as the subsequent layer N + 1, one metal layer 12c in a layer turned around the center axis (Figure 12), following one another in order to obtain the structure shown in Figure 13 in which the islands 20 of these layers N and (N + 1) lie on one another, while in the middle of each opening 18, of one layer, there is an area of the adjacent layer on which three crosspieces 19 meet one another without an island 20, as is shown in Figure 13. With the described structuring of the metal layers 12c therefore using the same metal layers, very finely structured capillary areas 8 with channels widely branched in all three solid axes can be produced simply by turning every other layer.

Figure 10 shows ~~in~~ a representation like Figure 9, ~~the~~ with a metal layer 13c for producing the vapor channel structure 9. The metal layer 13c in its structuring corresponds to the metal layer 12c, and differs from it simply in that some of the crosspieces 19, which run transversely to the lengthwise axis L, were omitted, such that the remaining crosspieces 19, together with the islands 20, form zig-zag band-like structures 21', which extend in the lengthwise direction L, with passages 21, which lie in between and

which extend in the lengthwise direction. According to Figure 16, the vapor channel area 9 is formed by at least two metal layers 13c being stacked on top of one another, and connected to one another, such that every other metal layer 13c is turned around the center axis so that also in the vapor area 9, the islands 20 of the individual layers 13c, come to rest on one another and in this way form continuous, post-like structures 16. The passages 21 yield flow channels with larger effective flow cross section for the vapor area 9.

Figures 17 - 22 show as further embodiments, metal layers 12d for forming the capillary structures 8, and the metal layers 13d, for forming the vapor channel structure 9. Figures 17 and 18 in turn show the same metal layer 12d, but Figure 18 in a layer turned around the center axis relative to Figure 17. Likewise, figures 20 and 21 show the same metal layer 13d, but in Figure 21 in a layer turned around the center axis relative to Figure 20.

The metal layer 12d is structured in the manner of the screen within the closed edge area 17, with a plurality of angled openings 22 which are oriented with the angle bisector of their angle segments parallel to the lengthwise axis L.

To form the respective capillary structure 8, at least one metal layer 12 in an unturned form, and one metal layer 12 in a turned form, are placed on top of one another, and are connected to one another, such that then the partially overlapping openings yield passages 23, via which the channels formed by the openings 22, in the individual layer, are joined to one another, into a widely branched channel structure, and in addition, post-like areas 16 result.

As Figures 17 and 18 show, the openings 22 are each located in several rows which follow one another in the direction of this lengthwise axis and which run perpendicular to the lengthwise axis L, the openings 22 each being offset from row to row on gaps.

The metal layer 13d, shown in Figures 20 and 22, differs from the metal layers 12d, simply in that, in addition to the openings 22, there are continuous openings which are bordered on the end by the edge area 17, and which extend in the lengthwise direction L, such that in turn band-like structures 24′ result, which extend in the lengthwise direction and which also have openings 22. By placing one unturned metal layer 13d, and one turned metal layer 13d, on top of one another on the band-like structures, additional channels are formed which are connected to one another via the passages 23, and also the post-like areas 16, which adjoin the areas 16 in the capillary areas 8 and are added to the continuous posts 16 between the metal layers 7.

Figure 23 ~~in~~ is another representation according to Figure 1. ~~as another embodiment~~ Figure 23 shows a cooler 1a in the form of a heat pipe. In this embodiment, the cooler 1a, or its body, is in turn formed from several copper or metal layers which are joined to one another lying stacked one top of one another to the cooler 1a. The metal layers 12e for the capillary areas 8 are made such that they are each provided on one surface side with several groove-like depressions 25 which extend in the lengthwise direction and which are produced by etching, stamping, or by machining which removes material or shavings, or in some other way. The

depressions 25 each end in a continuous opening 26, which is provided at a distance from a closed edge area. The metal layers 12e are then turned alternatingly to form the capillary areas 8, and are placed unturned on top of one another such that each depression 25 of one layer 12e is added to one depression 25 of the adjacent layer 12e to form a channel, as is shown in Figure 24. On the two ends, or areas 2 and 3, these channels then empty according to Figure 25, into spaces which are formed by openings 26, in the metal layers 12e and via which the channels are connected to the vapor channel 9.

The metal layers 13e, which form the vapor area, or the vapor structure, are made, for example, according to Figure 27, similarly to layers 12e, simply with depressions 27 of greater width and/or depth, or by the fact that according to Figure 28, in the metal layers 13e there is one opening 28 with a large area each.

Figure 29 shows ~~in one~~ a representation similar to Figure 24. ~~another possible embodiment of~~ The cooler 1a, is disclosed in which the metal layers 12e for forming the capillary structure, are not turned alternatingly, but are each in the same orientation so that the depressions 25 form especially fine channels.

In the above described embodiments it was assumed that the channels which form the capillary structures are free channels. ~~Basically~~ It is also possible to place an auxiliary material which supports and/or causes a capillary effect in these or other structured or shaped channels, ~~especially~~ also in channels with large effective cross sections, for example, in the form of a powder, for example in the form of a powder consisting of at

least one metal and/or metal oxide, for example copper and/or aluminum and/or copper oxide and/or aluminum oxide, and/or in the form of a powder consisting of at least one ceramic, and/or in the form of a powder from mixtures of the aforementioned substances, as is indicated by 29 in Figure 24.

Copper is suited for the metal layers, the metal layers ~~then for example~~ being joined superficially to one another using DCB technology or ~~by~~ active soldering. ~~For example also~~ Aluminum or an aluminum alloy is also suited for the metal layers. In this case, the metal layers are connected to one another ~~for example~~ by vacuum soldering. The thickness of the metal layers ~~is~~ can roughly be between 100 and 1000 microns and the structure widths in the area are between 50 and 1000 microns.

Reference number list

1,1a	cooler
2, 3	area
4 - 6	component
7	metal layer
7'	ceramic layer
8	capillary area
9	vapor channel area
10	cooling element
11	auxiliary cooler
12,12a,12b	metal layer
12c,12d,12e	metal layer
13,13a,13b	metal layer
13c,13d,13e	metal layer
14a, 14b	slot
15a, 15b	slot
16	posts
17	edge area
18	opening
19	crosspiece
20	island
21	opening
21'	structure
22	opening
23	passage
24	opening
24'	structure

25	depression
26	opening
27	depression
28	opening
29	auxiliary material

Abstract of the Disclosure

The invention relates to a novel design of a cooler in the form of a heat pipe, with a housing in which an interior space closed to the outside is formed to hold a liquid, vaporizable coolant or heat-transport medium.

#3

Declaration and Power of Attorney for Patent Application
Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

As a below named inventor, I hereby declare that:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

____

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My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

COOLER, IN PARTICULAR FOR ELECTRIC COMPONENTS

____

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deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

☐ wurde angemeldet am ____________
unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT)
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the specification of which is attached hereto unless the following box is checked:

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Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

German Language Declaration

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119 (a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderurkunden, oder § 365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land ausser den Vereinigten Staaten von Amerika benennen, und habe nachstehend durch ankreuzen sämtliche Auslands- anmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldetag dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Applications
(Frühere ausländische Anmeldungen)

(Number) (Nummer)	(Country) (Land)	(Day/Month/Year Filed) (Tag/Monat/Jahr der Anmeldung)	Priority Not Claimed / Priorität nicht beansprucht
198 17 383.0	Germany	20 April 1998	☐
198 18 839.0	Germany	28 April 1998	☐

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

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(Application No.) (Aktenzeichen) (Filing Date) (Anmeldetag)

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(Application No.) (Aktenzeichen) (Filing Date) (Anmeldetag) (Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)

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Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachten Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese eidesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Title 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können.

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number)*
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Unterschrift des zweiten Erfinders Datum	Second Inventor's signature Date
Wohnsitz	Residence
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(Im Falle dritter und weiterer Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.)

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